

NORTH CAROLINA  
**MARITIME** Strategy

**NC Maritime Strategy  
Market Scenarios**

**Prepared for the  
North Carolina Department of Transportation**

**by**

**AECOM  
in association with URS**

**June 26, 2012**

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## ACKNOWLEDGEMENTS

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Initiated by the Governor's Logistics Task Force (GLTF), the *North Carolina Maritime Strategy* takes a fresh look at North Carolina's maritime assets and the needs for improvement to ensure that our State remains competitive in the future. A *Maritime Strategy* Executive Team has been formed to oversee this process, evaluate the results and provide an objective technical and economic analysis. The *Maritime Strategy* Executive Team includes: Lieutenant Governor Walter Dalton; the Governor's Senior Policy Advisor, Al Delia; Secretary of Transportation, Gene Conti; Secretary of Commerce, J. Keith Crisco; and Secretary of Environment and Natural Resources, Dee Freeman. The following North Carolina Department of Transportation (NCDOT) and North Carolina Department of Commerce (NCDOC) staff have provided day-to-day direction, guidance and support for study execution: NCDOT Director of Strategic Initiatives, Roberto Canales PE; NCDOT Project Manager, Virginia Mabry; NCDOT Liaison to the Lieutenant Governor, W. Seth Palmer; NCDOT/Commerce Liaison Joseph (Jed) McMillan; and Transportation Consultant to NCDOT and Global TransPark, Charles Diehl.

A Maritime Advisory Council, comprising State officials and staff, along with industry representatives from ocean shipping, trucking, rail and manufacturing interests, as well as community-at-large representatives, has provided further guidance and support to the study team. A roster of Advisory Council membership is included in the appendix of this report.

Finally, broad-based stakeholder outreach is key to successful development of the statewide *Maritime Strategy*. A comprehensive and ongoing public involvement program has provided additional input to the study by engaging the public, agencies and others through a series of informational meetings, public workshops and focused discussions with industry, as well as environmental and community groups.



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## EXECUTIVE SUMMARY

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The *North Carolina Maritime Strategy* is being developed to connect maritime goods and economic development in North Carolina. This is accomplished through the following primary tasks:

- Facilitated collaboration of freight transportation, economic development and community interests as input to the statewide strategy,
- Definition of North Carolina's economic context and maritime market positioning strategies that would offer the greatest economic benefit to the State, and
- Identification of infrastructure investments and policies that would most significantly enhance North Carolina's economy through improved performance of the State's maritime gateways and related trade corridors.

The *North Carolina Maritime Strategy* will define maritime market scenarios in which the State could realize economic and public benefit. Opportunities to be explored include those associated with import and export of containerized cargo, as well as the potential for expanded bulk, breakbulk, petrochemical and military cargos. Special emphasis has been made to link potential market positions with industry in the State. The range of market position alternatives to be investigated may include regional transshipment of goods, container-on-barge service and major international container terminal operations.

For each viable market scenario, the Strategy will define its infrastructure needs. Transportation investments to be examined may include reconfiguration or modernization of existing port facilities, new terminal developments, wharf and channel improvements, road and rail connections, and inland intermodal facilities. A comparative analysis of development alternatives will be conducted to measure the relative benefits, effectiveness and costs associated with various alternatives for market positions and associated infrastructure.

As input to the presentation of a decision matrix of maritime investment alternatives and the assessment of candidate investments for consideration by the State of North Carolina, this *Market Scenario* technical memorandum develops projections of the North Carolina-based market potential.



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## TABLE OF CONTENTS

ACKNOWLEDGEMENTS .....	III
EXECUTIVE SUMMARY .....	V
TABLE OF CONTENTS .....	VII
LIST OF FIGURES .....	IX
LIST OF TABLES.....	XI
1 INTRODUCTION.....	1
1.1 Building upon North Carolina's Existing Industrial Strengths.....	1
1.2 Industries with Regional Growth Potential.....	2
1.3 Export and Import Commodities Requiring Specialized Infrastructure.....	4
1.4 Potential Market Scenarios.....	5
2 GRAIN.....	9
2.1 Factors Considered in the Grain Projection .....	9
2.2 Reasonableness of the Grain Projections.....	10
3 WOOD PRODUCTS.....	11
3.1 Factors Considered in the Wood Products Projection.....	11
3.2 Reasonableness of the Wood Products Projections .....	12
4 CONTAINERIZED CARGO .....	15
4.1 Factors Considered in the Container Projections.....	15
4.2 Reasonableness of the Container Projection .....	16
5 REFRIGERATED CARGO .....	17
5.1 Factors Considered in the Refrigerated Cargo Projections .....	17
6 RO/RO AND OVERSIZE CARGO .....	19
6.1 Factors Considered in the Ro/Ro and Oversize Cargo Forecast.....	19
6.2 Wind Power Industry .....	19
7 MILITARY CARGO.....	21
8 CHEMICALS AND PHOSPHATES.....	23
APPENDIX: PROJECTIONS AND COST ELASTICITY .....	25
Estimating Current Market Share .....	25
Projecting Baseline Growth .....	26
Estimating Change in Market Share .....	27



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## LIST OF FIGURES

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Figure 1: North Carolina Agricultural Exports, 2004-2009 .....	3
Figure 2: Grain Market Opportunity for North Carolina .....	9
Figure 3: Wood Products Market Opportunity for North Carolina.....	11
Figure 4: Wood Pellet Market Opportunity for North Carolina.....	12
Figure 5: State Economic Regions .....	13
Figure 6: State Economic Regions .....	14
Figure 7: Containerized Cargo Market Opportunity for North Carolina.....	15
Figure 8: Refrigerated Cargo Market Opportunity for North Carolina.....	17
Figure 9: Ro/Ro and Oversize Market Opportunity for North Carolina .....	19
Figure 10: Wind Power Equipment and Components Opportunity for North Carolina.....	20
Figure 11: US Military Depots and Military Bases in the Southeastern US .....	21
Figure 12: Chemicals and Phosphates in North Carolina .....	23
Figure A1: Example Elasticity Line Fit Plot.....	31



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## LIST OF TABLES

Table 1: Export Outlook for Refrigerated Commodities .....	4
Table 2: Overview of Candidate Market Scenarios for North Carolina .....	7
Table 3: Pulpwood Removals to Pulpwood Inventory by Economic Region .....	13
Table 4: Maritime Demand for Wind Power Components.....	20
Table A1: Illustrative Commodity Detail in the PIERS Records .....	26
Table A2: Summary of Baseline Market Volume Adjustments.....	29
Table A3: Cost Elasticity Regression Results.....	31
Table A4: Summary of Delivered Costs by Market Scenario (assumes Charlotte intermodal facility location) .....	32
Table A5: Summary of Diversion Assumptions Applied in the Scenarios.....	33



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## 1 INTRODUCTION

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In an increasingly global and interlinked economy, ports (air and sea) are gateways to the rest of the world. Although communication technology has made employees in many industries footloose, able to work nearly any location, technology has yet to untether goods from the need for efficient access to sea ports, nor the economy's reliance on these commodities. Moreover, in a highly mobile global economy, sensitivity to cost is heightened.

Firms regularly assess their location as part of paring production costs and remaining competitive. Efficient port access for all types of goods—consumer goods as well as commodities—remains an essential element of an integrated logistics strategy. The southeast region of the US is expected to remain attractive to migrants in coming decades, driving population growth rates above the national average. Freight trends will follow. Recent data from the US Bureau of Transportation Statistics reports that shippers are routing more cargo through US South Atlantic and Gulf Coasts in order to more readily access these growing consumer markets<sup>1</sup>.

Investments in North Carolina port facilities and associated landside infrastructure have the potential to support and strengthen the state's maritime trade by reducing import and export costs of North Carolina-based shippers. The potential to retain North Carolina freight that is currently exported through out-of-state ports is an important factor necessary to determine the potential for greater capture of the state's trade flows and the associated reduction in shipping costs, and ultimate realization of a maritime freight-focused economic development strategy.

For the State of North Carolina, the potential benefits of maritime trade include expanded markets for North Carolina-based producers via exports, which support local jobs and a diverse state economy, and increased quality and choices available for consumers and business via imports, which support local competitiveness and quality of life.

In addition to the value of the exports and imports to North Carolina's economy, the presence of the port facilities attract a variety of value-added services that support employment in industries such as trucking, rail, distribution, marine maintenance and repair services, and services to facilitate the trade transaction. The port activity also attracts industries that utilize heavy imported goods and bulk items such as manufacturing firms that employ the chemicals and forest products imported through the marine terminals in their production process, manufacturers assembling products from parts included in containerized cargo, and firms producing and consuming dry and liquid bulk cargo.

### 1.1 Building upon North Carolina's Existing Industrial Strengths

North Carolina's competitive industries are a barometer of the state's resource and technical advantages; these are industries that are sources of particular strength for the state's economy and future job creation. One consideration in framing the *Maritime Strategy* is ensuring that port investments support the needs of its most competitive port-using industries. Shift share analysis, as described in the *Target Market Conditions, Trends & Opportunities* technical memorandum, was applied to identify the state's competitive industries, defined as those that outperform the national average performance for that industry.

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<sup>1</sup> Chambers, Matthew. December 2011. "The Changing Tide of U.S.-International Container Trade: Differences Among the U.S. Atlantic, Gulf, and Pacific Coasts," BTS Special Report. SR-032.

Through evaluation of the state's overall industry mix, the national share held by various North Carolina industries (location quotient), and the regional shift of this industry share to or from the state between 2001 and 2009, North Carolina has outperformed the rest of the nation in the following industries:

- Forestry and logging
- Agriculture and forestry support activities
- Primary metal manufacturing
- Food manufacturing
- Paper manufacturing
- Chemical manufacturing
- Plastics and rubbery products manufacturing

Also of interest is wood product manufacturing, which has a high location quotient and has suffered only a small negative regional shift out of North Carolina over the last decade. Additionally, transportation equipment manufacturing and motor vehicle parts manufacturing have positive shift effects though small location quotients. This indicates some competitiveness, but they have not yet gained a foothold in the state's economy.

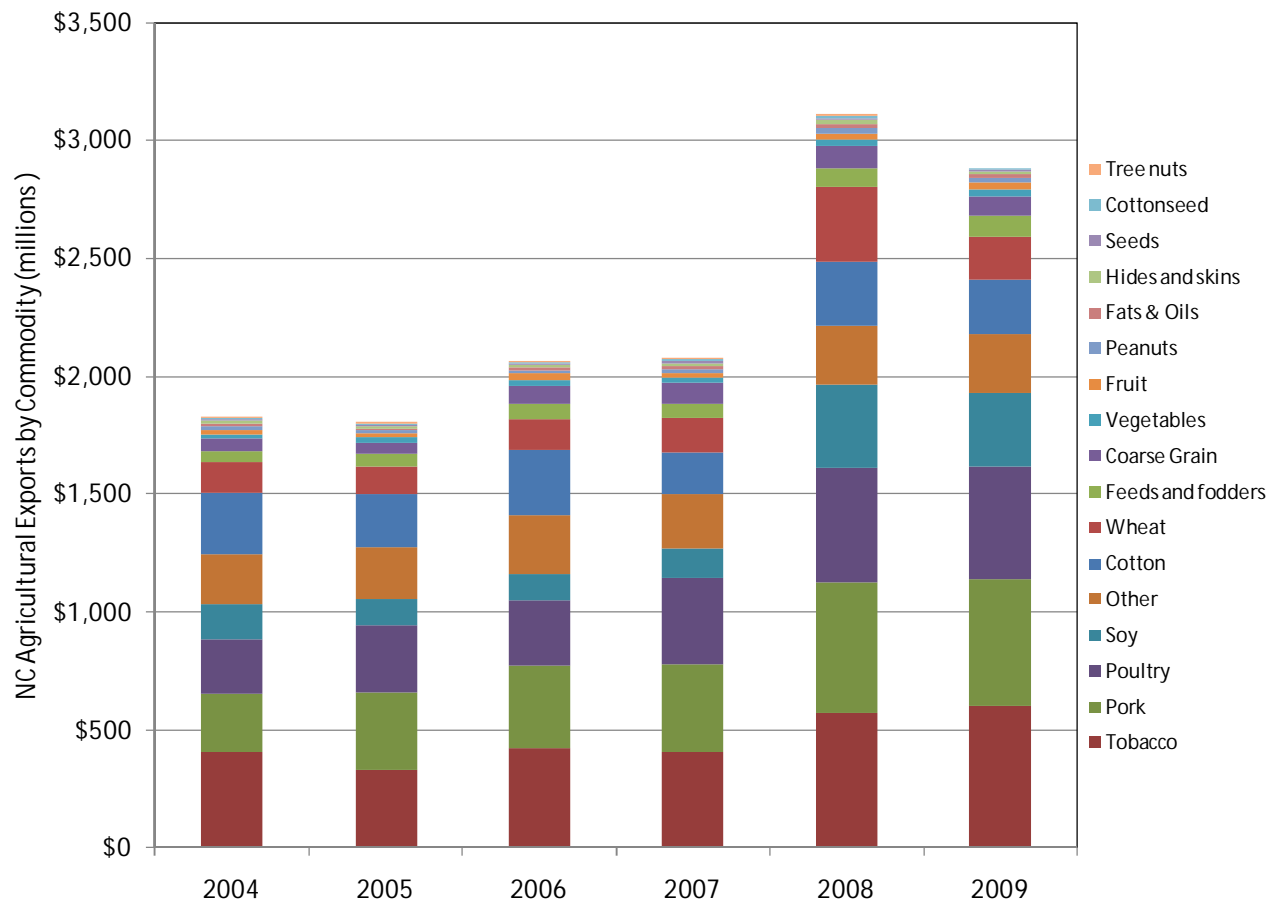
## **1.2 Industries with Regional Growth Potential**

Market opportunities were also identified by considering the projected growth in the overall regional market—driven by a fast-growing urban concentration in the Piedmont-Atlanta Megaregion, rising demand in China and other developing countries for US goods, and changes in shipping patterns.

As described in the *Target Market Conditions, Trends & Opportunities* technical memorandum, leading export products from the southeastern US in the coming decades include wood and paper products, meat, animal feed, textiles, cotton, special industrial machinery, and aircraft components.

Agriculture is another opportunity, with solid export growth projected for the region. As illustrated in Figure 1 below, North Carolina's agricultural exports posted solid growth in recent years, even during the recent global recession.

**Figure 1: North Carolina Agricultural Exports, 2004-2009**



Source: North Carolina Department of Agriculture

The analysis has focused primarily on exports because of the Strategy's objective to identify roles for the North Carolina ports to play in sustaining and strengthening the state economy—improving logistics for North Carolina's shippers and producers. The emphasis on economic development leads directly to an analysis of export opportunities and initiatives to improve North Carolina's shippers' connection and cost of access to markets. Imports, too, play a role. Investments in in-state container facilities can allow for the balance of exports and imports, with inbound containers available for outbound use by North Carolina's exporting industries. Containers are used to transport a variety of goods exported from the state; North Carolina shippers must now transport their products to more remote ports because empty containers and scheduled container service are not as readily available at NC Ports. By advancing North Carolina as a secondary container port, the State can provide for more cost effective access to container imports and exports for the North Carolina shippers.

### 1.3 Export and Import Commodities Requiring Specialized Infrastructure

The most significant driver of the ability for North Carolina maritime infrastructure to meet the goods movement needs of certain industries may be investments in specialized equipment to accommodate some of the state's key exports and market opportunities.

Another way to look at the data, apart from overall volume and pace of growth, is to combine commodities by the type of specialized equipment required for their handling. The following commodities are all potential users of specialized refrigeration equipment. This list omits several specialty products that fall with the larger commodity groups reported. For example, stakeholder interviews have identified that some types of textiles and rubber products must be kept cool. Shippers reported using the Port of New Orleans and other ports specifically for this reason; the requisite facilities to keep the commodity at a proper temperature were not available at the North Carolina port facilities.

In addition, these imports would pair well with the state's existing strengths in exporting agricultural products requiring refrigeration such as sweet potatoes, frozen poultry, and meat.

**Table 1: Export Outlook for Refrigerated Commodities**

	2009	2020	2029	2009 to 2020	2020 to 2029
<b>Total Commodities</b>	<b>79,578,018</b>	<b>118,911,098</b>	<b>151,291,294</b>	<b>49%</b>	<b>27%</b>
Beverages	1,007,407	1,501,440	2,031,706	49%	35%
Fruits & Vegetables, Fresh/ Chilled (Sensitive)	578,265	699,339	936,454	21%	34%
Fruits & Vegetables, Fresh/ Chilled/ Frozen	473,692	680,582	1,134,349	44%	67%
Fish & Seafood, Frozen	176,912	252,814	324,708	43%	28%
Meat, Fish & Dairy, Other	139,150	177,421	216,128	28%	22%
Fruits, Exotics	137,491	223,392	307,535	62%	38%
Meat, Frozen	49,704	47,723	53,439	-4%	12%
Fish & Seafood, Fresh/ Chilled	20,296	26,493	33,236	31%	25%
Dairy	17,248	18,738	22,314	9%	19%
Meat, Fresh/ Chilled	11,146	11,166	12,179	0%	9%
Fresh Cut Flowers, Foliage	2,420	5,224	5,638	116%	8%
<b>Total Commodities Potentially Using Refrigeration</b>	<b>2,613,730</b>	<b>3,644,332</b>	<b>5,077,688</b>	<b>39%</b>	<b>39%</b>

Source: IHS Global, August 2011 South Atlantic waterborne trade forecast

Grain and wood pellets represent another opportunity to share specialized equipment. Both have similar handling requirements—ventilation that handles dust, the need to be kept dry, and the ability to move a granular commodity. Unlike the refrigerated commodities above that might be jointly stored in a chilled or freezing facility—chicken, beef, vegetables—it is not envisioned that grain and wood pellets would be handled simultaneously in the bulk facilities. Rather, the facility could be transitioned from one commodity to another as needed. The key point here is that in both cases there is more than one North Carolina commodity market to use the facility, reducing the risk that market conditions shift and “strand” the investment.

Provided that there is the requisite equipment and capacity to handle freight, relative costs are the next important driver of diversion potential. Particularly for key North Carolina commodities such as forestry and agricultural products, profit margins are thin, making these commodities highly sensitive to differences in shipping costs. Investments to improve the landside travel time

and reliability can change the relative costs between shipping locations in North Carolina's favor.

#### **1.4 Potential Market Scenarios**

An overview of candidate market scenarios identified and evaluated for North Carolina is presented on Table 2 below. Each is described in more detail in the sections that follow.



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Table 2: Overview of Candidate Market Scenarios for North Carolina

	Grain		Wood Pellets		Other Wood Products		Container		Refrigerated Cargo		Ro/Ro & Oversize	
Foreign Nodes	Asia via Panama Canal		Asia via Panama Canal, Europe		Africa, Asia via Panama Canal, Asia via Suez Canal, Europe, Mediterranean		Africa, Asia via Panama Canal, Europe, Asia via Suez Canal, west coast of S America via Panama Canal		Africa, Asia via Panama Canal, Caribbean, Europe, east coast of South America		Africa, Asia via Panama Canal, Asia via Suez Canal, Europe, Mediterranean	
Domestic Nodes	Soybean producing counties in North Carolina		Lumberton Western North Carolina		Lumberton Western North Carolina		Intermodal yards in Charlotte and Greensboro; distribution centers in the Triangle Region		Intermodal yards in Charlotte and Greensboro; distribution centers in the Triangle Region; sweet potato producing counties in North Carolina		Manufacturing centers in Kinston, Triangle Region, Greensboro, Winston-Salem, and Charlotte	
Port	Morehead City	Wilmington	Morehead City	Wilmington	Morehead City	Wilmington	Morehead City	Wilmington <sup>2</sup>	Morehead City	Wilmington <sup>2</sup>	Morehead City	Wilmington
Inland Corridors	US 70	US 17 US 74/US 76 US 258/NC 24	I-140 US 17 US 70 US 74/US 76 NC 24	I-140 US 74/ US 76	I-140 US 17 US 70 US 74/US 76 NC 24	I-140 US 74/US 76	I-40 I-95 US 70	I-40 I-74 US 74/US 76	US 70	I-40 US 74/US 76	I-40 US 1 US 70	I-40 US 17 US 74/US 76
Inland Mode (2040)	90% Truck / 10% Rail		50% Truck / 50% Rail		80% Truck / 20% Rail		70% Truck / 30% Rail		90% Truck / 10% Rail		50% Truck / 50% Rail	
2040 Volume												
Container							1.26 million TEU		73,000 TEU			
Bulk	730,000 tons		450,000 tons		990,000 tons							
Break Bulk					320,000 tons						96,000 tons	
Ro/Ro											96,000 tons	
Special Equipment	Dedicated storage silos, on-dock rail unloading facility, covered conveyors to load vessels		Dedicated storage silos, on-dock rail unloading facility, covered conveyors to load vessels		Chippers and conveyors for woodchips, storage sheds for wood pulp and lumber		100 ft-gauge dockside cranes, RTG cranes or ASC for container handling, on-dock intermodal rail		Refrigerated warehouse, reefer plug-ins in the container yard		200-ton mobile harbor cranes	
Potential Partner / Competitor	Portsmouth, VA Colonel's Island Terminal, Savannah, GA (major agri-bulk)		Marine Terminal, Savannah, GA (huge pellet business and expanding)		Veteran's Terminal, SC (2.8 MIL tons storage)		Savannah, GA (capacity) APTm, VA (efficiency)				Ocean Terminal (largest & expanding) & Colonel's Island Terminal, Savannah, GA	
Regional Growth (2012-2040)	0.96% CAGR		1.95% CAGR		2.03% CAGR		3.29% CAGR		2.95% CAGR		2.15% CAGR	

<sup>2</sup> Wilmington includes three alternative sites within the Wilmington Harbor

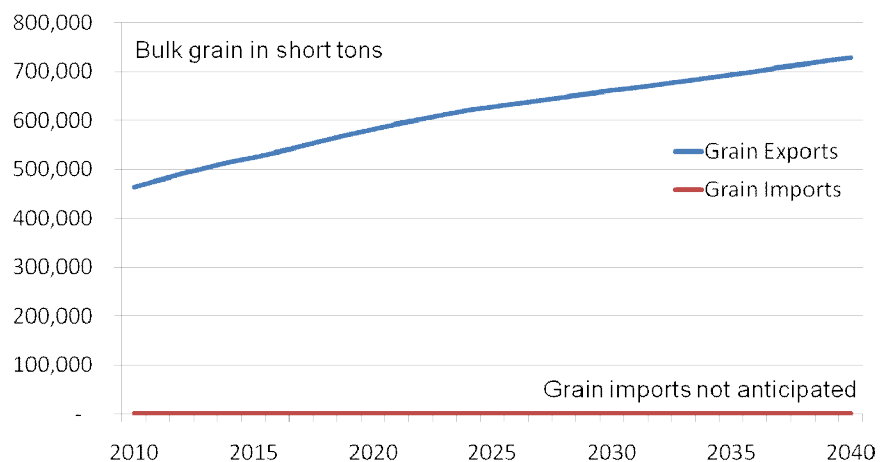
	Grain	Wood Pellets	Other Wood Products	Container	Refrigerated Cargo	Ro/Ro & Oversize
Link to NC Economy	Agriculture and agribusiness comprise nearly 20 percent of NC jobs and income: 52,400 farms and over 50,000 jobs in food manufacturing. Supports non-metropolitan areas.	NC timber production supports 2,800 jobs in forestry and logging; 20,000 jobs in wood product manufacturing; supports non-metropolitan areas of the state.		Manufacturing and retail account for 24% of state GDP; consumption (products purchased by households including imports) accounts for about two-thirds of the economy.	NC is leading US producer of sweet potatoes; second in poultry, pork, trout, and Christmas trees; third in processed cucumbers and strawberries.	Durable goods manufacturing is 7% of GDP; about 28,000 jobs in transportation equipment manufacturing; over 30,000 jobs in machinery manufacturing.
	Supports existing industry by increasing profitability and opening up new markets. Landside improvements have spillover benefits for the general public.	Wood pellet market opens up a new market for an important state industry. Maritime market focus on other wood products supports an existing industry by increasing profitability.		This maritime market reduces the shipment cost for a variety of industries across the state, thereby improving profitability.	This maritime market offers niche services to support the state's large agriculture industry and specialty manufactured goods.	This maritime market supports the aerospace industry, manufacturing of heavy equipment and capital goods for export as well as the state's military needs and Wind Power initiative.

TEU = twenty-foot equivalent unit      RTG = rubber tired gantry      ASC = automated stacking cranes      Lo/Lo = lift-on/ lift-off      Ro/Ro = roll-on/ roll-off      CAGR = compound annual growth rate  
\* 2040 volumes are volumes generated by NC-based demand.

## 2 GRAIN

Soybean exports account for ten percent of North Carolina's agricultural exports; adding in wheat and feed grains and products, and the combined grain total rises to 18 percent of the state's exports and about \$490 million for the state's economy<sup>3</sup>. As a result, market options are important for the state. North Carolina's soybeans are attractive to export customers because they tend to have higher protein and oil content than the average bean grown nationally<sup>4</sup>. The data analysis (described in the appendix) finds solid prospects for grain exports and growers reported in interviews that they could produce more than they currently do.

**Figure 2: Grain Market Opportunity for North Carolina**



Source: AECOM, from PIERS and IHS Global Insight

Grain markets are seasonal; soybean producers, for example, market about 65 percent of their beans between October and December<sup>5</sup>.

### 2.1 Factors Considered in the Grain Projection

As the state's ports do not have a bulk handling facility, the majority of North Carolina's exports go to out of state ports, adding to producers' costs and paring back margins. A small portion travels by container through Wilmington. Even a small savings in transportation costs could yield significant savings for this industry, with multiplier effects for the North Carolina economy. The projections assume that the state's current bulk grain exports would shift to North Carolina facilities if the requisite bulk handling and storage equipment were available<sup>6</sup>. Growth of this market is consistent with projections for waterborne grain exports from the Southeast region. This is supported by the comparative proximity of producers to the state's ports which reduces the cost of shipping through the state's facilities compared with out-of-state facilities, the current

<sup>3</sup> Based on 2010 data compiled from the USDA Economic Research Service using data from the US Department of Commerce, the Census Bureau and the US Department of Agriculture, National Agricultural Statistics Service and reported in North Carolina's Agricultural Statistics, page 35.

<sup>4</sup> Stakeholder interviews and reported in "Opportunities for Containerized Exports of North Carolina Soybeans," a report to the North Carolina Soybean Producers Association prepared by Market Solutions LLC, September 2008.

<sup>5</sup> Ibid.

<sup>6</sup> As there are no bulk exports from the state's ports currently—an effective market share of "0," a cost elasticity could not be applied."

use of in-state facilities for those shippers who export containerized grain, and information provided by agricultural shippers. Information from the cost modeling shows that use of an in-state location yields a savings to shippers were the necessary handling equipment available (see Table A4 of the appendix).

## **2.2 Reasonableness of the Grain Projections**

The 2010 projection in the figure above represents approximately 11 percent of the state's grain (soybeans, wheat, corn for grain) production by volume, according to statistics from the North Carolina Department of Agriculture<sup>7</sup>. This is on par with the state's current export share<sup>8</sup>. This is important as it demonstrates that it does not measurably alter the share of production available to the state's large animal production industry. Growth is supported by projections for regional grain exports, the expectation of strong foreign demand—particularly from Asia, anticipation of gradually rising yields, the ability to supply the projected volumes based on conversion of fallow or marginal fields to production as farmers receive higher prices, and confirmation from growers who attended the agricultural stakeholders workshop that they have the capacity to grow more than they currently produce. Projected volumes are derived from historical tonnages at NC Ports as reported by PIERS and other industry sources, historical tonnages and growth forecasts for the southeastern US region, and anticipated cargo diversions that would be realized by proposed infrastructure investments. Please see the appendix for details.

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<sup>7</sup> North Carolina Department of Agriculture and Consumer Services. 2011. "County Estimates" for Soybeans, Wheat and Corn for Grain (3 documents), page 2.

<sup>8</sup> North Carolina Department of Agriculture and Consumer Services. 2011. Presentation entitled "North Carolina Soybean Infrastructure" by Tom Slade. Slide 10 states that soybean exports are less than a 1/10<sup>th</sup> of production.

### 3 WOOD PRODUCTS

Heavy commodities such as wood and wood products are particularly sensitive to transportation costs. Potential for improved landside access and handling facilities at North Carolina's ports supports this large industry's ability to capture its maximum share of the world market. The state has an above average concentration in the wood products industry, but its competitiveness is weakening based on the shift share analysis described in the *Target Market Conditions, Trends and Opportunities* technical memorandum. Support for this industry and opening up opportunities to capture the wood pellets market would bolster this industry.

**Figure 3: Wood Products Market Opportunity for North Carolina**



Source: AECOM, from PIERS and IHS Global Insight

#### 3.1 Factors Considered in the Wood Products Projection

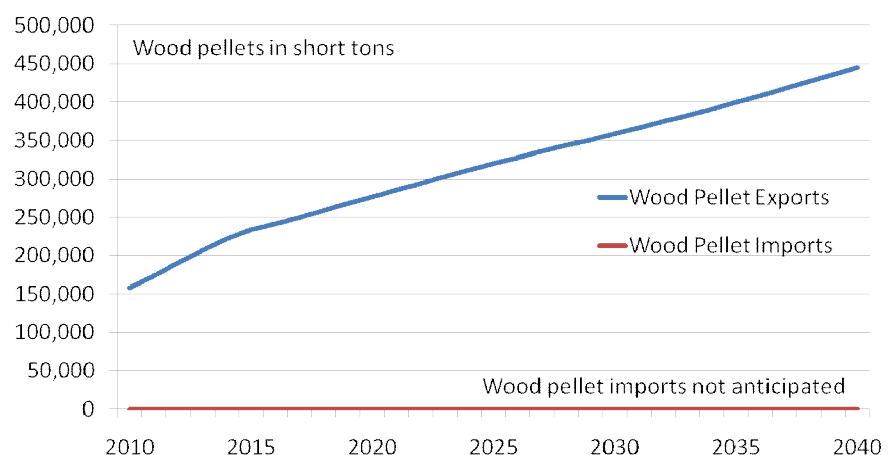
The projections assume growth of North Carolina's existing market consistent with projections for waterborne wood products exports from the Southeast region combined with a modest diversion of some North Carolina shipments that currently use out-of-state ports. As described in the appendix, an estimate of the cost elasticity was developed that found maximum 6 percent diversion but research also suggested lower rates for close ports. In the case of wood products, which is already an established and mature market and where the primary long-term changes over the forecast horizon are landside access improvements in the outer years, the 3 percent was factored downwards to 2.5 in order to avoid overstating the potential diversion. In addition, the stakeholder workshop identified a growing trend toward containerization that would dampen growth of some bulk wood product shipments. If the subsequent benefit cost analysis (BCA) finds that this investment passes the 1.0 threshold with these conservative projections, the investment has upside potential in terms of its potential return.

The wood pellets industry, by contrast, is an emerging industry, and is driven by UK and European initiatives to convert energy sources to renewable ones. For example, in the UK 15 percent of energy consumption must be from forms of renewable energy by 2020 (versus approximately one percent in 2007). The electricity supply must be 35 percent from renewable sources by 2020, in comparison to about five percent in 2007. This is creating a large market for wood biomass that cannot be met domestically.

North Carolina is well positioned in terms of resources to serve this market. One pellet facility has already opened in the state; its location near the Virginia state line and the company's purchase of a port terminal in Chesapeake mean that this first firm will export out of Virginia rather than North Carolina. The example, however, underpins the importance of transportation costs for this industry—favoring locations such as North Carolina with both the wood resource and port access. As a new industry for the state, a cost elasticity approach cannot be applied as the effective market share currently is zero. Instead, the approach here was to assess the market potential through interviews with knowledgeable stakeholders. The analysis assumes that three small pellet plants open in the state over the forecast horizon and sizes the projections based on that basis. This is likely

a conservative projection as the industry is new and evolving to larger plants in some cases. Stakeholders were divided here over whether the plant projection (150,000 short tons of final product annually) was too low or about right for resource or market conditions. As a result, the projections are potentially conservative, but opinion is divided on the market outlook.

**Figure 4: Wood Pellet Market Opportunity for North Carolina**



Source: AECOM, from PIERS and IHS Global Insight

### 3.2 Reasonableness of the Wood Products Projections

An important concern in evaluating the forecast is whether the state's resources could sustain both the wood pellets projections and the wood products projections. Data from the North Carolina Cooperative Extension Office confirms that the state has sufficient resources to support the volumes projected here without reducing overall resource stocks. Data from the Forest Service indicate that statewide, North Carolina's forests are adding more growth each year than is harvested. This ratio, however, varies by region as indicated in the table below. The figure shows the physical location of each region for reference.

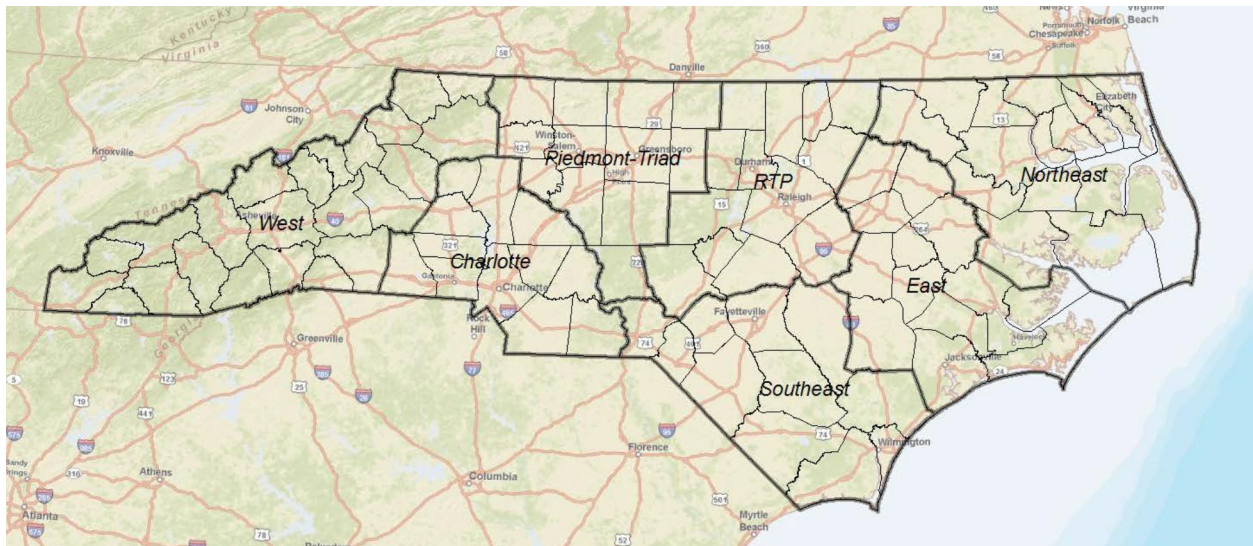
Analysis conducted by the North Carolina Cooperative Extension Services has found that because of the different growth rates between softwood and hardwood pulp, a percentage below 5 percent indicates that softwood is being harvested sustainably—that growth equals or exceeds the pace of removal. A percentage 3 percent for hardwood indicates that the resource is being harvested sustainably. As the table shows, the regions with greatest proximity to the ports are being harvested at sustainable rates of growth and most have room for growth.

**Table 3: Pulpwood Removals to Pulpwood Inventory by Economic Region**

Region	Percent Pulpwood Removal to Pulpwood Inventory	
	Softwoods	Hardwoods
West	4.8%	0.7%
Charlotte	2.4%	1.2%
Piedmont-Triad	2.1%	1.1%
RTP	2.3%	2.0%
Northeast	3.6%	3.0%
East	2.5%	2.4%
Southeast	2.9%	3.0%

Source: North Carolina Cooperative Extension Service

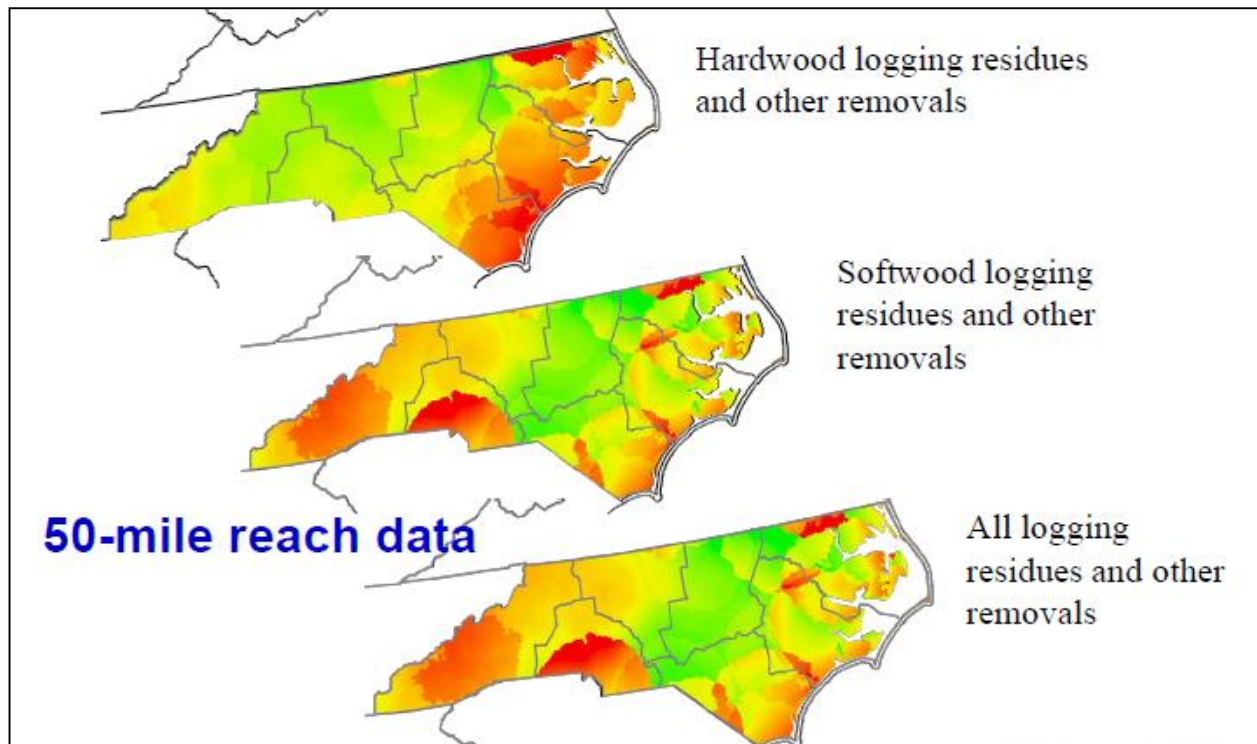
**Figure 5: State Economic Regions**



Source: North Carolina Cooperative Extension Service map of North Carolina Department of Commerce regions

The last part of the wood resource discussion is the availability of wood residues. This is particularly important for the pellet industry which is “omnivorous” in the wood that it can use. The figure below, developed by the Cooperative Extension Service, shows the availability of logging residues and other removals. This estimates the net amount potentially available annually. Red areas show where negative values exist. This does not mean foresters are out harvesting all the hardwood and softwoods in those areas - it simply means harvesting rates do not generate enough logging residues and other removals to meet the drain and that existing facilities need to reach a little further beyond the 50-mile radius used in the analysis to meet their needs. As timber markets start to increase - there will be more available logging residues. Orange through green denote increases in availability. Green could be as high as 2-3 million tons in a 50-mile area. In short, there is plenty of biomass resource.

**Figure 6: State Economic Regions**



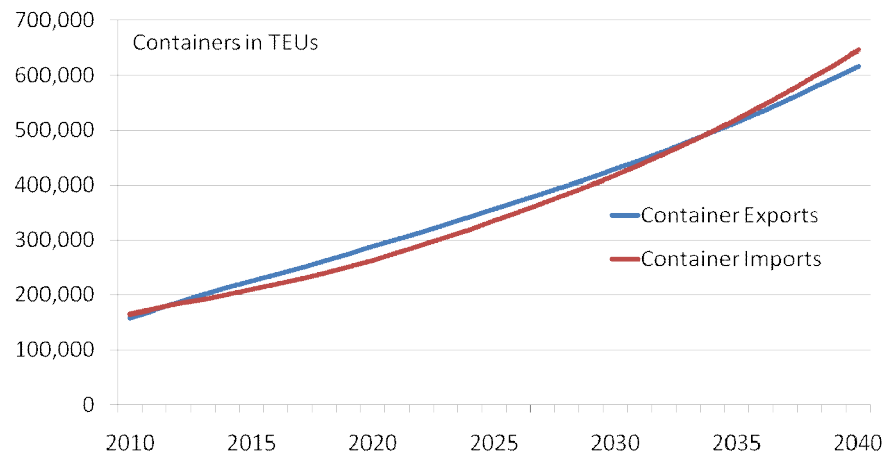
Source: North Carolina Cooperative Extension Service analysis, 2011

## 4 CONTAINERIZED CARGO

North Carolina added 1.5 million people between 2000 and 2010, one of only six states to add more than one million during the decade. To put that in perspective, 12 states have **total** populations less than 1.5 million—the

number that North Carolina added in a decade. Moreover, the state's metropolitan communities frame the northern segment of the emerging Piedmont Atlantic Megaregion. In short, the state is becoming one of the nation's most populous states and is becoming part of a growing urban economy. This consumer market is attractive to retailers and will generate demand for a full range of consumer goods.

**Figure 7: Containerized Cargo Market Opportunity for North Carolina**



Source: AECOM, from PIERS and IHS Global Insight

Container handling supports both export and import activity across a large variety of industries--everything from sweet potatoes and frozen chickens to consumer goods destined for local retailers. Growth in container activity at the port would make North Carolina's facilities more attractive ports of call for shipping lines, expanding the market reach for NC producers, making it easier to secure containers, and creating scale economies.

Cost-effective delivery of containerized goods to North Carolina users and consumers of foreign products is not the only reason that the waterborne container market is important to the state. North Carolina producers that export their goods by container must transport – primarily by truck – their goods to the nearest port at which empty containers are available and regular overseas service by container shipping lines is provided. Development of the infrastructure and services to support a strong import container market will also support the competitiveness of containerized exports originating from North Carolina.

### 4.1 Factors Considered in the Container Projections

The projections assume growth of North Carolina's existing market consistent with projections for waterborne containerized export goods from the Southeast region combined with a modest diversion of some North Carolina shipments that currently use out-of-state ports. Please see the appendix for a discussion of the analysis. The overall summary container baseline forecast growth rate is built up from the individual containerized goods growth rates. As the NC Ports are already recognized for high productivity and low cost in the handling of containers, the diversion occurs because of the improvements at Charlotte which make this large and growing urban market more accessible to the ports and widen the cost advantage attributable to the state's

facilities. As described in the appendix, an estimate of the cost elasticity that relates changes in cost to changes in market share was developed that found maximum diversion potential of about 6 percent; that is a one percent change in cost translates into a six percent change in market share, all other things held equal. In the case of container goods, 1.25 percent was applied as the potential diversion potential, a reflection of the finding that cost accounts for 20 to 30 percent of market share (see appendix). The elasticity above is thus in the lower range of reported elasticities.

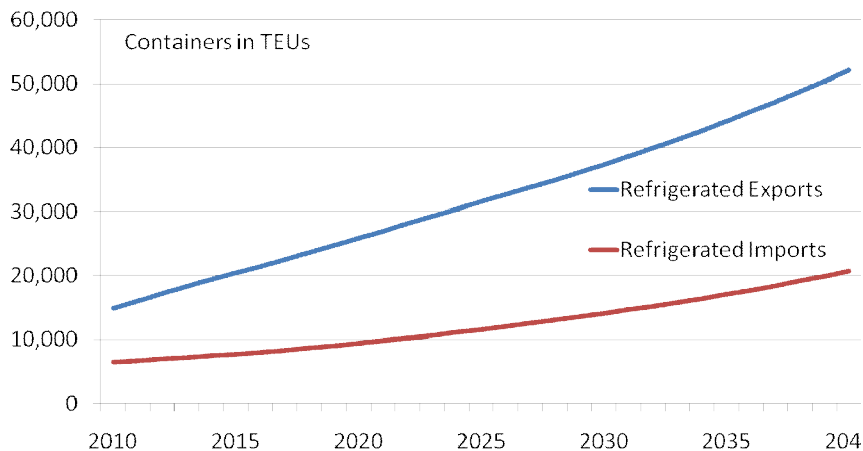
## **4.2 Reasonableness of the Container Projection**

A low diversion rate was selected as North Carolina already has a cost advantage on average with its competitors but it does not dominate the market. Thus, non-cost factors play a large role here. As described more fully in the appendix, while cost is a critical factor in determining market share, many variables influence a shipper's decision to use a port. These include the availability of ship calls, availability of value added services, and availability of containers among other factors. While North Carolina's ports currently have the capability to handle containers, the improvements at Charlotte described in the *Capital Costs by Market Scenario* technical memorandum remove a bottleneck and make the port more accessible for a highly populated region of the state. The resulting CAGR of 3.29 percent is well within the range of projections reported by other studies reviewed for this *Strategy Study*. To the extent that the projections are low, this translates into lower estimated benefits in the BCA, providing upside risk to the findings.

## 5 REFRIGERATED CARGO

The ability to handle refrigerated cargo supports the export of a variety of the state's agricultural commodities, to handled specialized manufacturing inputs that require low temperatures, as well as food imports to serve the region's growing population. Key agricultural commodities served by this investment include the state's exports of poultry, pork, and seafood. Sweet potatoes, too, benefit from temperature control. North Carolina is the nation's leading producer of sweet potatoes. Refrigeration supports imports, as well. North Carolina-based shippers who participated in the stakeholder workshops noted that they imported specialized textiles and rubber products through out of state ports because the requisite facilities were not available in state. The region's growing population creates a healthy market for imported fruits and vegetables and other perishables such as flowers.

**Figure 8: Refrigerated Cargo Market Opportunity for North Carolina**



Source: AECOM, from PIERs and IHS Global Insight

In capitalizing on this opportunity, the port's access to non-traditional food retailers such as Target and Wal-Mart, in addition to chain grocery store distribution centers, helps in attracting an import perishable foods operator. North Carolina has demonstrated success in attracting grocery distribution centers, with the recent decision of Save-A-Lot to build a distribution center in Lexington.

The company operates

24 Save-A-Lot stores in North Carolina, including one in Lexington, and plans to open an additional three stores by 2012. Save-A-Lot has identified North Carolina and the broader area as a "key region for growth." Food Lion, another grocery chain, expanded its existing Dunn distribution center in 2011. The ability to handle refrigerated cargo thus supports important existing North Carolina industries and manufacturers, but also offers the potential to increase the flow of imports through the ports, offering important truck backhaul opportunities, and potentially expanding the range of carriers that call on North Carolina's ports, providing upside potential to the import projections.

### 5.1 Factors Considered in the Refrigerated Cargo Projections

The method of projecting refrigerated containers is consistent with that for general containers—the diversion factor applied is slightly higher than general containers because of the perishable nature of the commodity at 1.5 percent-- and is described in greater detail in the appendix. The projections are conservative for the same reasons described in the container section. Aside from a diversion factor at the low end of the range, the impact of marketing initiatives and export

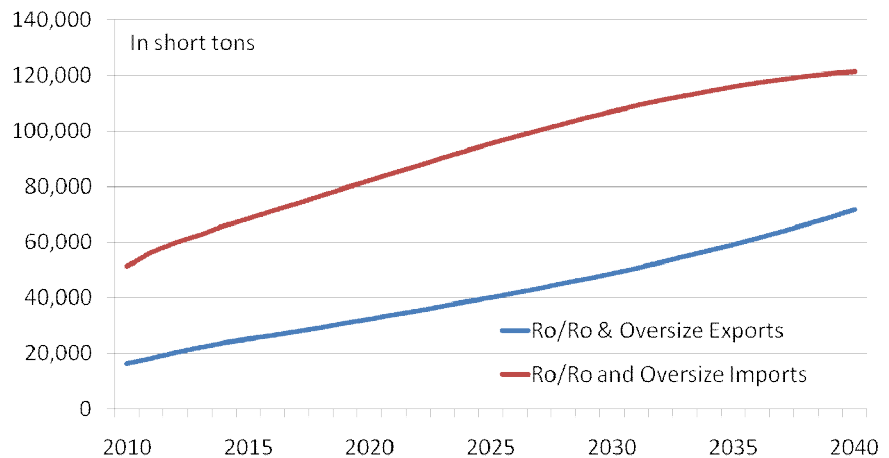
growth among growers currently closed out of the export market represent upside risks to the forecast.

## 6 RO/RO AND OVERSIZE CARGO

The state's low costs of doing business make it an attractive location for producers of capital goods. Moreover, the state's competitiveness in metals and machinery supports the outlook for a growing capital goods industry. Ensuring that the state has the capability to handle large project cargos supports important existing firms and industries such as the local military facilities as well as Spirit and Caterpillar. It also makes the state an attractive

candidate for the relocation and expansion of other capital goods producers; these are attractive firms because they purchase significant inputs from their host economies, generating larger than average multiplier effects.

**Figure 9: Ro/Ro and Oversize Market Opportunity for North Carolina**



Source: AECOM, from PIERS and IHS Global Insight

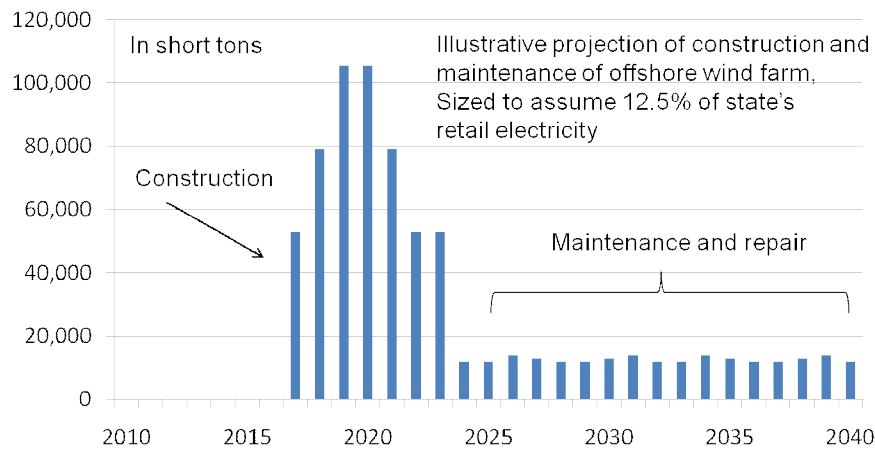
### 6.1 Factors Considered in the Ro/Ro and Oversize Cargo Forecast

The projections assume growth of North Carolina's existing market consistent with projections for waterborne oversize and Ro-Ro exports goods from the Southeast region with a modest diversion. The six percent maximum elasticity is factored down to 4.5 in this scenario to reflect the more limited landside travel options available to such cargo. The outlook for Ro/Ro and oversize is heavily influenced by military policy decisions and the relocation decisions of capital goods manufacturers in the state. The Ro/Ro and oversize investments help to support these valuable industries and ensure that the state is prepared to compete for them, but the large and heavy nature of these goods makes them difficult to divert compared to other goods.

### 6.2 Wind Power Industry

As a subset of the Ro/Ro and oversize market, North Carolina is actively considering offshore wind power as a new industry. The Governor has convened a task force to evaluate whether and how best to pursue the opportunity. A study by the University of North Carolina concluded that the state could supply 100 percent of its power from off-shore turbines. Moreover, the state has a goal of supplying 12.5 percent of its power from renewable sources. This initiative represents an opportunity for the port. During the construction phase, North Carolina's ports would be the focus for imports and exports of equipment and materials for the offshore site. Once built, the freight volumes would fall, but the ports would serve as a service base to maintain and operate the offshore facility. Finally, the presence of the large scale facility and the state's attractive business costs could attract wind power manufacturers to the state, creating upside potential for equipment exports from the state.

**Figure 10: Wind Power Equipment and Components Opportunity for North Carolina**



Source: AECOM, from wind power equipment specifications

Specifically, the analysis assumes the following is based on the inputs and calculations presented in Table 4 below.

**Table 4: Maritime Demand for Wind Power Components**

Line	Item	Value	Notes
A	NC Retail Electricity Sales	136,414,947	MW in 2010 (Energy Information Administration)
B	Projected Sales in 2020	166,289,059	MW in 2020 (Energy Information Administration)
C	12.5 Percent	20,786,132	MW by calculation from line above
D	Conversion to KWh	20,786,132,400	1 MW = 1000 KWh
E	KWh per Nacelle	10,800,000	Annual estimate for 3.6 MW GE turbine reported in State of New Jersey Offshore Wind Blue Ribbon Panel Energy and Wind Systems 101 The Basics, page 9.
F	Number of Turbines Needed	1,925	Line D divided by Line E
G	Weight per Turbine Unit	267 tons	National Wind Watch, middle range of offshore models
H	Total Weight to Construction Offshore Windfarm Producing 12.5%	513,879 tons	Line F X Line G
I	Conversion to stons	565,267	1 ton equals 1.1 ston
J	Long-term Shipment Needs for Maintenance	Varies by year but assumed to be around 15,000 to 17,000 stons per year	Major overhaul costs less than 1% of total cost—assumes parts for three full turbines entirely replaced each year—storm damage could increase this in particular years. Same source as Line E, page 12.

## 7 MILITARY CARGO

North Carolina has the fourth-largest active duty military population in the US distributed among seven military installations and 14 US Coast Guard facilities, according to research conducted on behalf of North Carolina Department of Commerce<sup>9</sup>. Military facilities support over 416,000 workers, about eight percent of total state employment, through direct military or Coast Guard employment or jobs supported by military installations in the state such as contractors or support services.

The US Military is investigating changes to its traditional equipment maintenance and reset functions to include an end-to-end Defense Logistics Organization (DLO). Challenges presented by shrinking budgets and mandated consolidation are forcing the examination of the equipment reset process, which includes: redeployment of equipment from overseas; assessment for heavy or light repair; transport to inland depots in Alabama and Georgia for rehabilitation or major overhaul; and, finally return to base – primarily in North Carolina. Through its North Carolina Defense Logistics Initiative, the North Carolina East Region Military Growth Task Force has changes in the marine reset logistics to redirect North Carolina-bound equipment through NC Ports to eliminate several hundreds of miles of equipment transport. The potential economic benefits and impacts of this concurrent effort are not evaluated in this report. Rather, the *Maritime Strategy* seeks to identify port-related infrastructure that would also support military use. The potential redirection of military Ro-Ro cargo through North Carolina is a large upside risk to the Ro-Ro/Oversize projections.

**Figure 11: US Military Depots and Military Bases in the Southeastern US**



Source: North Carolina Logistics Initiative, Military Growth Task Force

<sup>9</sup> Sara Nienow, Chris Harder, Tim Cole, and Anna Lea. "North Carolina's Military Footprint: Current Economic Impacts and Projections for 2013" The Policy, Research, and Strategic Planning Division of the North Carolina Department of Commerce with assistance from Adam Cooper (REMI). June 2008.

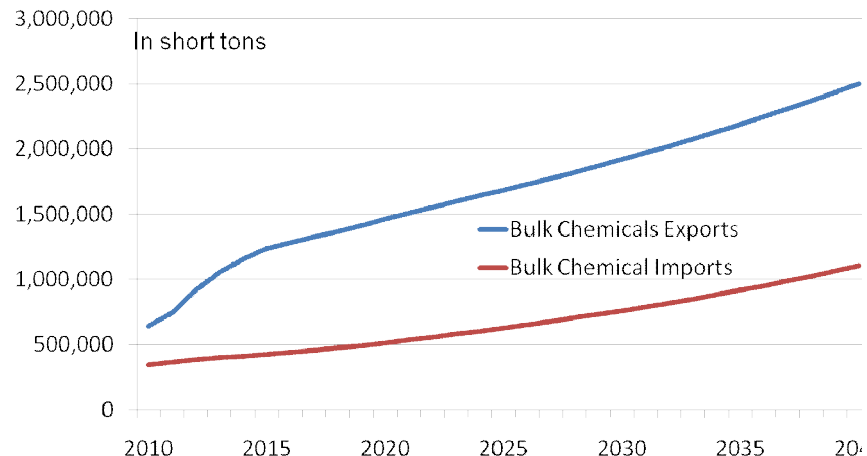
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## 8 CHEMICALS AND PHOSPHATES

Chemicals are a major existing export for North Carolina's port facilities, show up as a comparative strength for the state's economy, and have solid export prospects going forward. The anchor for the state's industry, PCS, has a long-term lease on a terminal at Morehead City and mines potash in Aurora, NC. The

company's phosphate operations "mine phosphate ore and manufacture phosphoric acid, solid and liquid fertilizers, animal feed supplements, purified phosphoric acid which is used in food products and industrial processes, hydrofluosilicic acid ("HFSA") and silicon tetrafluoride ("STF")."<sup>10</sup> The Aurora facility has a capacity of 1.2 million tonnes  $P_2O_5$  of phosphoric acid per year; the company reports that it is the largest integrated phosphate mine and phosphate processing complex at one site in the world.

**Figure 12: Chemicals and Phosphates in North Carolina**



Source: AECOM, from PIERS and IHS Global Insight

The company has long-term leases on shipping terminals in Morehead City and Beaufort, North Carolina, through which the company receives and stores Aurora facility raw materials and finished product. Barges and tugboats are used to transport solid products, phosphoric acid and sulfur between the Aurora facility and shipping terminals. Raw materials and products, including sulfur, are also transported to and from the Aurora facility by rail, according to the company's reports.

Existing reserves for the Aurora facility would permit mining for about 33 years. If deposits covered by permits are classified as resources, the mine life extends to about 52 years, confirming that this is a long-term opportunity for North Carolina. State investments in pursuit of new maritime opportunities should be supportive of this existing market.

<sup>10</sup> Summary of PCS operations drawn from 2010 10K report and supplemental filings with the US SEC. Report accessed at [http://www.potashcorp.com/annual\\_reports/2010/media/PotashCorp\\_10-K\\_110225.pdf](http://www.potashcorp.com/annual_reports/2010/media/PotashCorp_10-K_110225.pdf).



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## APPENDIX: PROJECTIONS AND COST ELASTICITY

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Development of the market scenarios was a data-intensive exercise requiring three key elements: 1) an estimate of the current market share, 2) a projection of baseline growth for the market, and 3) an estimate of how baseline growth might change with candidate investments. The balance of this appendix describes the approach and assumptions used in developing the market scenarios. The approach utilizes several sources of data in order to take advantage of the best elements of each. As described in more detail below, the overall strategy was to:

- Estimate North Carolina's port market share of North Carolina trade (excluding shipments from out of state using a North Carolina port) using PIERS data. The PIERS data was also benchmarked to data from the North Carolina State Ports Authority to adjust for an overall undercount in the data.
- Because PIERS is an historical data set, IHS data projections were applied to grow out the current market to yield a baseline market projection—expected growth in North Carolina trade using a North Carolina port.
- Use regression results based on FHWA FAF data, supplemented by qualitative market information, to determine the potential to divert North Carolina shipments currently using out of state ports to North Carolina's ports.

### Estimating Current Market Share

The estimate of current market share uses PIERS data as the starting point. The data records provide information on the shipper, the shipper's location, the port of departure/entry, type of commodity, tonnage, whether the commodity was containerized, and the foreign origin or destination. While there are both strengths and weaknesses to using the PIERS data for this type of analysis, there is no better source of data. Strengths are the level of detail in the data, especially the indication of whether the commodity was containerized, as many types of freight may be shipped breakbulk/bulk or via containers—logs in North Carolina for example. The chief weakness is that some records are miscoded for the origin—reporting the origin for the headquarters or distribution location that arranged for the shipping as opposed to the physical production location that is needed for this analysis.

In order to overcome the coding problem, the individual records were pulled and sorted by transit through North Carolina ports, and those of its chief competitors—Norfolk, Charleston, and Savannah. An initial estimate of the volume of North Carolina goods traveling through these ports was then estimated. The remaining records were then reviewed to determine whether there were coding errors. If there appeared to be a miscoding, these were reassigned to the North Carolina market. Because the PIERS data provides the company name, the coding effort entailed researching the company's production locations to see if the product was produced in that reported location and whether a North Carolina facility for that same company could be identified for the same commodity. Similarly, for particularly larger shippers with many shipments in the database, the balance of the shipper's cargo pattern was reviewed to see if other shipments were originating/ending in North Carolina. If a commodity could be definitively determined as miscoded using other supplemental research, it was reassigned. There were several cases where the pattern of trade reported in the PIERS data seemed unusual, but it could not be definitively disproved. In this case, the record was not reassigned to avoid overstating the market share and subsequent results. A similar process was followed to identify coding errors for North Carolina-originating goods flowing through out-of-state ports. This was a

very labor intensive process—there were over 19,000 individual export records for North Carolina ports alone--and given the *Strategy's* emphasis on economic development, the bulk of the effort focused on the export side of the market and on larger shippers—individual shippers that only appear in the data a handful of times with small volumes were not evaluated. Thus, the estimates of market share are conservative.

A final adjustment was made based on a comparison of the PIERS data to information from the NCSPA. When PIERS totals for all containers traveling through North Carolina facilities (independent of origin/destination) were compared to data from NCSPA, the PIERS totals were lower, suggesting that some shipments are missed. Thus, a final adjustment was made to 1) factor the PIERS totals up to be consistent with 2009 NCSPA totals and to adjust for growth between 2009 and 2010 to yield the most up-to-date historical point on which to base forecast growth.

### **Projecting Baseline Growth**

In order to develop a baseline growth projection—growth that would be expected to occur in the absence of an investment—the team purchased independently produced projections from IHS Global Insight, a nationally-known firm specializing in freight forecasting. Of particular note, the projections are for waterborne exports and imports only, and exclude growth in the commodities examined that might travel via other modes as well—trucked exports to Canada for example. The projections are for commodities traveling from the Southeast Atlantic Coast.

As the level of commodity detail in the PIERS data used to develop the historical market shares is fine—an example is provided in Table A1 below—the PIERS records had to be matched and aggregated to the 77 commodity groups projected by IHS Global in order to obtain a corresponding growth rate. In addition, IHS does not directly project containerized cargo. In developing the growth rate for containerized goods, the PIERS information describing which goods travel via container was cross-referenced with the 77 commodity groups to create an aggregate weighted growth rate for containerized cargo based in the IHS data. The resulting growth rates were applied to the historical base year market volumes (corrected for miscoding as described above) to yield a baseline projection of North Carolina commodities using North Carolina ports.

**Table A1: Illustrative Commodity Detail in the PIERS Records**

CASEIN,CELLULOSE CMP,POLISH
SURFACE ACTIVE AGENTS NSPF
VITAMINS,ANIMAL FEED SUPPS
SURFACTANTS,IONIC,NSPF
EPOXIDE,PEROXIDE,OXIDE
AMINE,AMIDE,IMIDE,LACTAM,NCO
ORGANIC,INORGANIC ACID ESTER
BENZENOID CHEMICALS

Source: PIERS

## Estimating Change in Market Share

In order to support the market forecasting scenarios, particularly the potential for diversion of existing cargo from out-of-state ports to North Carolina ports associated with landside improvements that alter the cost structure, a regression analysis was developed. The analysis drew data from the FHWA Freight Analysis Framework database for full origin—commodity—destination groupings for North Carolina's ports and its major coastal competitors. By comparing the commodity volumes moving along particular trade routes, the relative market share for the combination can be estimated.

There are multiple factors about a shipper's supply chain that affect routings and ultimate port selection. Shippers moving more valuable cargo are more likely to place more emphasis on speed because of the inventory cost incurred while the goods are in transit. These shippers will work to consolidate this supply chain to a core set of larger distribution centers and contract with shipping lines to minimize uncertainty in ship calls. For smaller shippers who lack direct relationships with carriers, other factors include the range of foreign destinations served by the port, range of domestic destinations readily accessible by truck and by rail, availability of containers, and availability of specialized equipment such as refrigeration facilities. An additional factor is the mix of goods shipped. For example, if a shipper exports multiple commodities, the effort will be to consolidate transport and storage to the degree possible. The implication here is that even if a particular commodity was a candidate of an alternative port, the shipper might still ship that commodity with the other cargoes in order to simplify the overall logistics operation. In short, there are multiple non-cost factors that weigh on the shipping decision. Many of these factors cannot be projected in a way that permits quantitative modeling, thus the cost—market share elasticity—must be applied with caution to avoid overstating this effect. Because there are a number of uncertainties that cannot be quantified, the diversion factor actually applied is always lower than that suggested by the regression analysis based on supplemental market information obtained from industry sources and the shipper workshops. What this means for the subsequent BCA analysis is to the degree that the diversions assumed here are low, the estimated benefits are similarly low—providing upside risk to the analysis.

Moreover, there is inertia in the logistics system due to established business relationships, long-term contracts, and time needed to learn about new market opportunities. For that reason, the elasticities were factored downward in particular markets as described in the main text. The elasticities were used to inform the diversion by answering the question—"If North Carolina's port had the requisite equipment, services, and capacity, what is the potential volume gain associated with the port's relative cost savings where the port has an advantage?"

The estimation of cost elasticity compares relative market share with relative market cost where there is sufficient data. In order to have sufficient data points, commodities had to be grouped in order to fit the equation. The regression was estimated in log-log form and confirmed that cost was a statistically significant predictor of market share at the 95 percent level. The regressions also confirm that many other factors are at play in the analysis. Cost alone accounts for about 20 to 30 percent of the variation in market share. Again, these were across all commodities so there will be variation across individual commodities and the results here should be applied conservatively with additional knowledge of the market.

A summary of the initial market shares, the individual adjustments, and the subsequent diversion volume assumed in the historical base value is provided in Table A2 below. The table is broken into two sections—those market projections that used PIERS as the base as

described above. Where the market scenario was for a commodity or for a new market that does not appear in PIERS or where reliable additional industrial data could be used to augment the PIERS information, data on volumes were generated from other sources as described in the main text of this appendix and noted in the table.

**Table A2: Summary of Baseline Market Volume Adjustments**

	NC Shipment Through NC Port (PIERS 2009)	NC Shipment Through Out- of-State Port (PIERS 2009)	Implied NC Market Share	Adjusted for Miscoding NC Shipment Through NC Port (PIERS 2009)	Adjusted for Miscoding NC Shipment Through Out- of-State Port (PIERS 2009)	Revised NC Market Share	Adjusted for Undercount Relative to NCSPA Counts or Other Benchmark	Adjustment to 2010 Base for NC Shipments Through NC Ports	Comparable Adjusted Total for NC Shipments Through Out-of- State Ports	Additional NC Shipments Diverted to NC Ports	Projected 2010 Base for Forecast
<b>EXPORTS</b>											
Containers (TEUs)	38,195.8	72,144.3	0.35	60,801.4	77,121.0	0.44	72,223.0	92,797.9	116,927.6	65,236.24	158,034.12
Refrigerated goods (TEUs)	1,193.0	1,292.6	0.48	5,083.0	6,142.6	0.45	6,037.9	7,757.9	9,313.1	7,150.01	14,907.95
RO-RO (stons)	2,850.7	1,923.1	0.60	2,850.7	8,822.4	0.24	3,386.2	4,350.8	13,376.1	11,939.57	16,290.39
Wood products	Based on PIERS, WISER Data and North Carolina Agricultural Statistics										386,829.79
Grain (stons)	Based on WISER Data and North Carolina Agricultural Statistics										463,829.47
Wood pellets (stons)	New Industry; No Historical Experience; Based on Industry Peers and Validated with NC Cooperative Extension Service Analysis										158,000.90

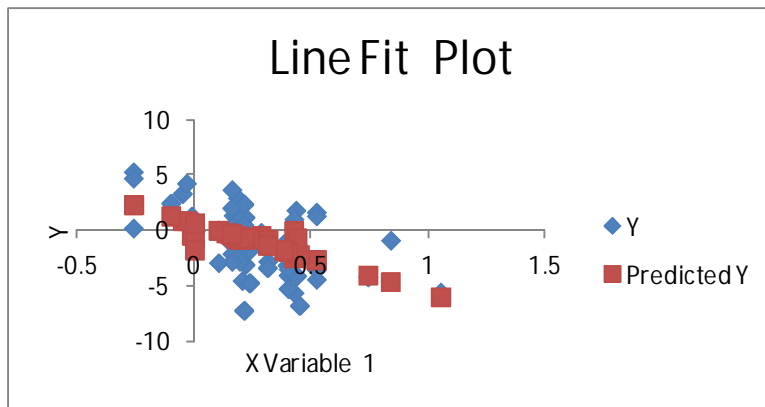


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**Table A3: Cost Elasticity Regression Results**

SUMMARY OUTPUT								
Regression Statistics								
Multiple R	0.54							
R Square	0.29							
Adjusted R Square	0.28							
Standard Error	2.21							
Observations	77							
ANOVA								
	df	SS	MS	F	Significance F			
Regression	1	148.5274812	148.5275	30.40237	4.76293E-07			
Residual	75	366.4043697	4.885392					
Total	76	514.9318509						
	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	0.67952209	0.374845799	1.812804	0.073864	-0.067209022	1.426253	-0.06721	1.426253203
X Variable 1	-6.32847509	1.147744862	-5.51383	4.76E-07	-8.614900062	-4.04205	-8.6149	-4.04205011

**Figure A1: Example Elasticity Line Fit Plot**



The elasticity of trade, defined as the change in market share relative to the change in cost, was relatively stable across port comparisons—ranging from 2 percent to 6 percent in most cases. This is consistent with other studies that have examined ports that were located in comparative proximity to one another along the coast<sup>11</sup>. Elasticities between ports that are more physically distant tend to be greater—in the range of 6 percent to 8 percent in many cases while ports located more closely have lower diversion rates. Finally, the elasticity described by the equation will vary over the range of the regression because it is a non-linear relationship. This further argues for tailoring the cost elasticity to the particular commodity, market maturity, and market conditions. Again, because of the large number of factors that cannot be quantified, the

<sup>11</sup> “Container Diversion and Economic Impact Study: The Effects of Higher Drayage Costs at San Pedro Bay Ports,” report prepared for the Port of Los Angeles and the Port of Long Beach, September 2007, page 15.

elasticity that was applied in each market scenario was factored downward—sometimes significantly based on market information in order to avoid overstating potential benefits. As an example of how the market share elasticity was applied, the container scenario is used as an example. At the top end of the spectrum, a 1 percent increase in cost yields a 6 percent loss of market share—this is how the equation is specified—hence the negative sign on the independent variable. Similarly, a 1 percent decrease in cost on average yields a 6 percent gain in market share with the understanding that cost only accounts for 20 to 30 percent of actual market change. From Table A2, a 1 percent change in market share is equivalent to a 2,097 TEU increase in containers ( $92,798 + 116,928 =$  total potential North Carolina market times 0.01). The cost model indicates that the average total delivered cost from a typical North Carolina location (as described in the *Delivered Cost Model* technical memorandum) is well below the cost to ship to Norfolk, Charleston, and Savannah in 2010 indicating that non-cost factors play a significant role in this market. These costs are shown in Table A4 below.

**Table A4: Summary of Delivered Costs by Market Scenario (assumes Charlotte intermodal facility location)**

	Total Delivered Costs in 2010						Total Delivered Costs in 2040				
	POW	MHC	Norfolk	Charleston	Savannah		POW	MHC	Norfolk	Charleston	Savannah
Grain	\$ 37.54	\$ 46.13	\$ 54.46	\$ 56.66	\$ 56.13	Grain	\$ 34.21	\$ 43.86	\$ 49.24	\$ 72.96	\$ 55.08
Wood	\$ 93.10	\$ 106.80	\$ 115.49	\$ 109.89	\$ 114.28	Wood	\$ 91.78	\$ 105.50	\$ 112.15	\$ 133.19	\$ 115.37
Wood Pellets	\$ 76.98	\$ 90.59	\$ 98.71	\$ 93.08	\$ 97.19	Wood Pellets	\$ 75.66	\$ 89.29	\$ 95.38	\$ 116.23	\$ 98.27
Containers (a)	\$ 520.17	\$ 918.34	\$ 997.38	\$ 910.10	\$ 973.45	Containers	\$ 519.36	\$ 892.48	\$ 871.30	\$ 1,139.84	\$ 895.87
Refridgerated	\$ 585.36		\$ 837.57	\$ 781.85	\$ 828.32	Refridgerated	\$ 585.36		\$ 720.64	\$ 983.65	\$ 762.64
RoRo	\$ 88.19	\$ 94.03	\$ 112.11	\$ 111.24	\$ 107.70	RoRo	\$ 98.66	\$ 108.24	\$ 119.05	\$ 151.41	\$ 130.51
Note: (a) Cost with intermodal center relocation in Charlotte. The 2010 POW container cost WITHOUT the relocation is \$758/TEU											
The implied reduction in container cost with the intermodal center is thus							31%				

Based on cost alone, the North Carolina's ports should have a larger share of the market. While the *Strategy* has recommended initiatives to improve marketing and the competitive position of the ports, there is inertia and a number of factors outside of the port's control. Thus while the change in cost associated with the intermodal improvement is large, it was factored down to account for these non-cost factors. Moreover, the cost projections for 2040 (see the *Delivered Cost Model* technical memorandum) indicate that Norfolk and Savannah will remain higher cost shipping locations but that the margin diminishes over time based on landside improvements made by each of the states.

The change in costs associated with relocation of the intermodal center at Charlotte is a reduction from \$758/TEU (noted below the table) to \$520/TEU (shown in the table) or about 31 percent. Based on the application of the elasticity estimated above, the change in relative costs is a comparison between \$758 vs. \$960.31 (the average out-of-state delivered costs: \$997.38 for Norfolk, \$910.10 for Charleston, and \$973.45 for Savannah) and \$520 vs. \$960.31 (that same cost). Thus, the intermodal improvement changes the relative cost structure from a 21 percent average savings to a 46 percent savings, a change of 25 percent. On net, the diversion was calculated as a 1.25 cost elasticity ratio (one fifth of the projected 6 percent elasticity--deliberately conservative given non-cost factors described above) applied to the relative change in cost. Thus, the volume of trade through North Carolina's ports is projected to increase by 31 percent over the current projected volume of North Carolina freight traveling through North Carolina ports or 65,000 TEU ( $1.25 \times 25 \times 2,097$ ).

The final diversion factors applied in the analysis are summarized below for those scenarios. Note that the diversion factor for wood is derived in a slightly different way as the bulk wood

data in PIERS did not fully align with other market sources. The value in the table is provided for comparison. The wood products estimate also combined data from WISER and industry sources and thus followed the same approach but not the exact steps shown for the other commodities.

**Table A5: Summary of Diversion Assumptions Applied in the Scenarios**

	<b>Diversion Factor</b>	<b>Relative Cost Change</b>	<b>Volume Change in Base Year</b>	<b>Notes</b>
Containers (TEUs)	1.25	25 percent with intermodal center relative to without	65,000	Detailed discussion above.
Refrigerated goods (TEUs)	1.5	28 percent with intermodal center relative to without	7,150	Slightly higher diversion rate than overall containers because this is a perishable good typically and more sensitive to travel time and distance.
RO-RO (stons)	4.5	15 percent cost advantage rising to a 23 percent cost advantage in 2040	12,000	A higher diversion factor is applied as the state already has a cost advantage suggesting that loading equipment is a factor. A higher diversion factor is applied because of the difficulty in transporting such goods. The factor is still below the 6 percent estimated diversion to be conservative given uncertainties in the data.
Wood products (stons)	2.5 (implied)	18 average cost advantage rising to a 31 percent cost advantage in 2040.	174,000	This is a cost sensitive industry but mature relative to grain. Cost advantage relative to Charleston and Savannah expected to erode yielding greater wood market share.
Grain (stons)	5.0	17 percent	387,000	Currently grain is traveling to more expensive markets, driven by the absence of requisite equipment. This is a highly cost sensitive commodity that is produced in close proximity to the ports so a higher diversion factor is applied.
Wood pellets (stons)	NA	NA	NA	Diversion approach not possible as industry is just getting established. Projection based on plant characteristics in North Carolina, average production is about 150,000 short tons though some recent plants are larger. There is a 20 percent cost advantage for domestic producers who use a North Carolina port if the handling capabilities exist.

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